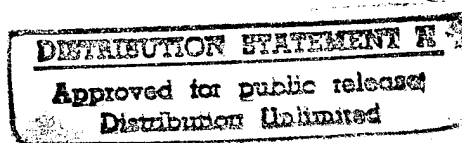


G & G  
-2013

1711

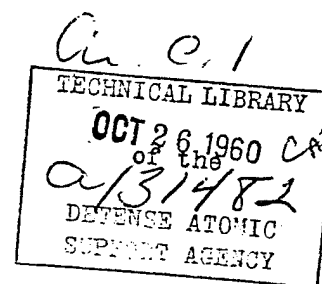


EDGERTON, GERMESHAUSEN & GRIER, INC.



FIREBALL CALCULATIONS  
SHOT HAMILTON  
OPERATION HARDTACK PHASE II  
PROJECT 15.1

19960702 073



DISTRIBUTION STATEMENT A APPLIES  
PER NTPR REVIEW.

*Robert B. Rogers* DATE 4/25/96

BOSTON, MASSACHUSETTS • LAS VEGAS, NEVADA  
SANTA BARBARA, CALIFORNIA

REPORT NO. B-2013  
29 JANUARY 1960

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ISST

Defense Nuclear Agency  
6801 Telegraph Road  
Alexandria, Virginia 22310-3398



29 May 1996

MEMORANDUM FOR DEFENSE TECHNICAL INFORMATION CENTER  
ATTENTION: OCD/Mr. Bill Bush

SUBJECT: Documents for DTIC System

There is no record of your office receiving the following reports:

EGG-B-2024 (29 January 1960)  
Fireball Calculations Shot Sanford  
Operation Hardtack Phase II  
Project 15.1

EGG-B-2013 (29 January 1960)  
Fireball Calculations Shot Hamilton  
Operation Hardtack Phase II  
Project 15.1

Both documents are now approved for public release.

Therefore, we are transmitting copies for inclusions into the DTIC system, if not already there.

Enclosure:  
A/S

*Arndith Jarrett*  
ARDITH JARRETT  
Chief, Technical Support

DTIC QUALITY INSPECTED 4

FIREBALL CALCULATIONS  
SHOT HAMILTON  
OPERATION HARDTACK, PHASE II  
PROJECT 15.1

Report No. B-2013  
29 January 1960

Prepared by R. C. Schneiderhan  
R. C. Schneiderhan

Approved by D. F. Seacord, Jr.  
D. F. Seacord, Jr.

EDGERTON, GERMESHAUSEN & GRIER, INC.  
Boston, Mass.      Santa Barbara, Calif.      Las Vegas, Nev.

# FIREBALL CALCULATIONS: SHOT HAMILTON

## 1.0 INTRODUCTION

Shot Hamilton, a 50-foot tower shot sponsored by LRL, was detonated at 0800 PST, on 15 October 1958 in Area TF-1 of the Nevada Test Site. The fireball yield was  $0.43 \text{ ton} \pm 0.09 \text{ ton}$ .

## 2.0 CAMERA INSTRUMENTATION AND OPERATION (Table 1)

Photographic coverage of Hamilton fireball growth was provided by two high-speed Eastman cameras and one high-speed 16 mm Fastax camera at Station 527.01 (6 x 6 No. 2) and a similar camera complement at Station 527.02 (6 x 6 No. 3). In addition, two Rapatronic cameras were located at Station 527.01 to record early fireball growth. The EG&G framing camera, running at an approximate speed of 15,000 frames per second, was located at Station F-732 (6 x 6 No. 1) to record additional early fireball behavior. One Eastman camera from Station 527.02 did not record the complete fireball. All other cameras obtained records suitable for analysis.

The station locations and the burst location are shown in Fig. 1. Figure 2 contains a summary of the survey data.

## 3.0 RESULTS

Because the yield of Hamilton was well below the range of constant  $\phi^5$  scaling<sup>1</sup>, the  $\phi$  comparison technique as defined in EG&G Report No. B-1869, "Fireball Calculations - Shot Eddy", was employed to determine the yield. A yield of  $0.43 \text{ ton} \pm 0.09 \text{ ton}$  is indicated.

<sup>1</sup>  $\phi^5$  scaling is usually applicable only for yields greater than 2 kt.

An air density of 1.098 grams per liter was used in the yield calculations. The air density value was based upon a pressure of 910 millibars, a temperature of 15.0°C, and a relative humidity of 30 percent at shot time.

The table below gives the comparison shots, and the Hamilton yield obtained by the  $\emptyset$  - comparison.

Comparison Shot	Hamilton Yield (tons)
<u>Balloon</u>	
La Place	0.495
Wheeler	0.374
Santa Fe	0.499
Lea	0.452
Hidalgo	0.450
<u>Air Drop</u>	
Buster B	0.404
Wasp'	0.408
Ranger A	0.398
Wasp	0.419
Ranger E	0.423

Comparison Shot	Hamilton Yield (tons)
<u>Tower</u>	
Hornet	0,422
UK-3	0.419
Rio Arriba	0.456
Quay	<u>0.431</u>
	$\overline{W} = 0.432$

Diameter vs time and  $\phi$  vs time plots are shown in Figs. 3, 4, and 5.

The following data sheets are included for each film:

- (a) Photo Plan and Photo Loading Chart
- (b) Camera Data and Calculation Sheet
- (c) Diameter Measurement Sheet
- (d) E102 print-out sheet of D, t, and  $\phi$ .

Selected frames of fireball films are contained in the Appendix.

The zero-frame times of the motion picture camera records were determined by comparing these records with the Rapatronic diameter vs time data.

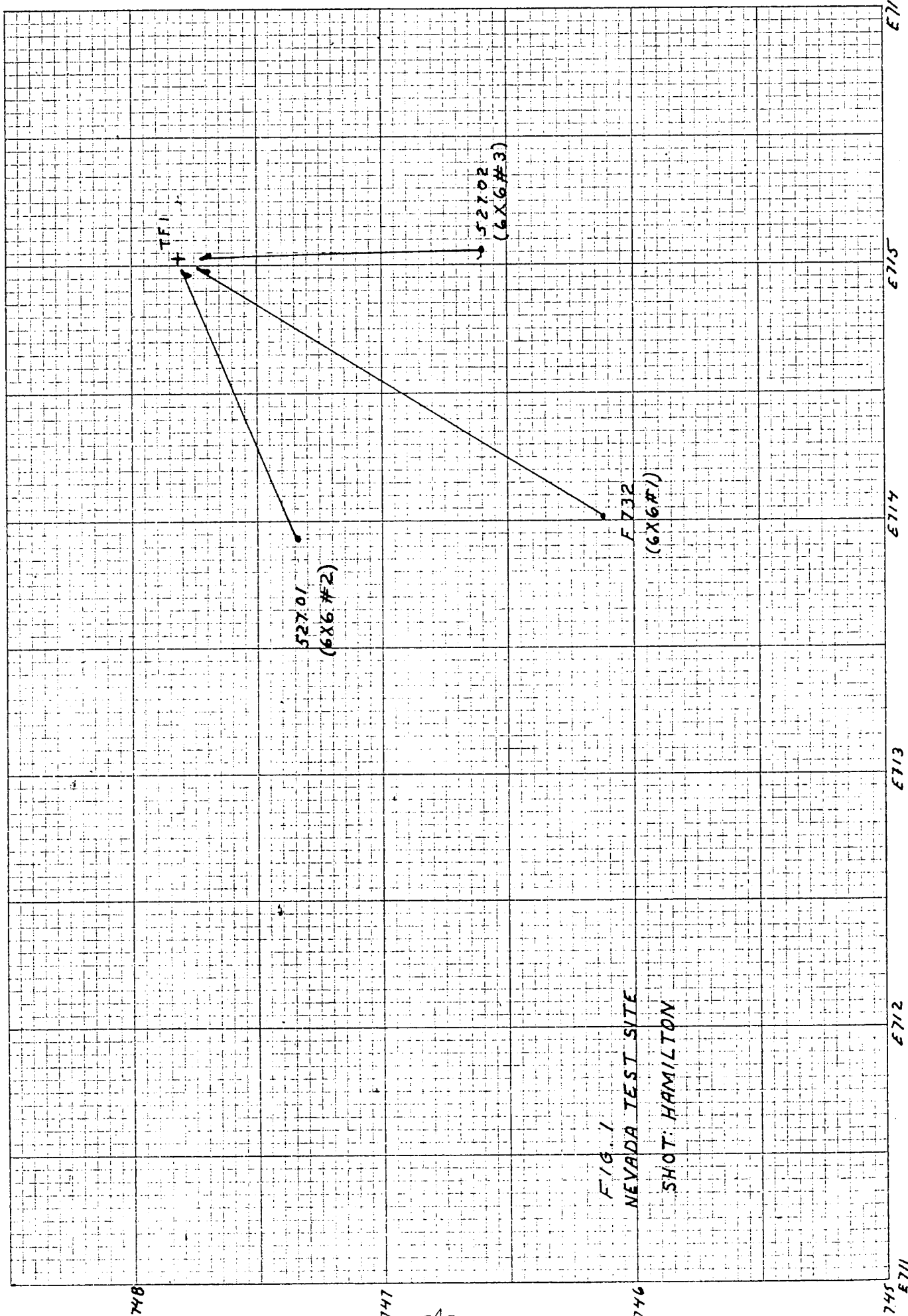




FIG. 2

# SURVEY DATA

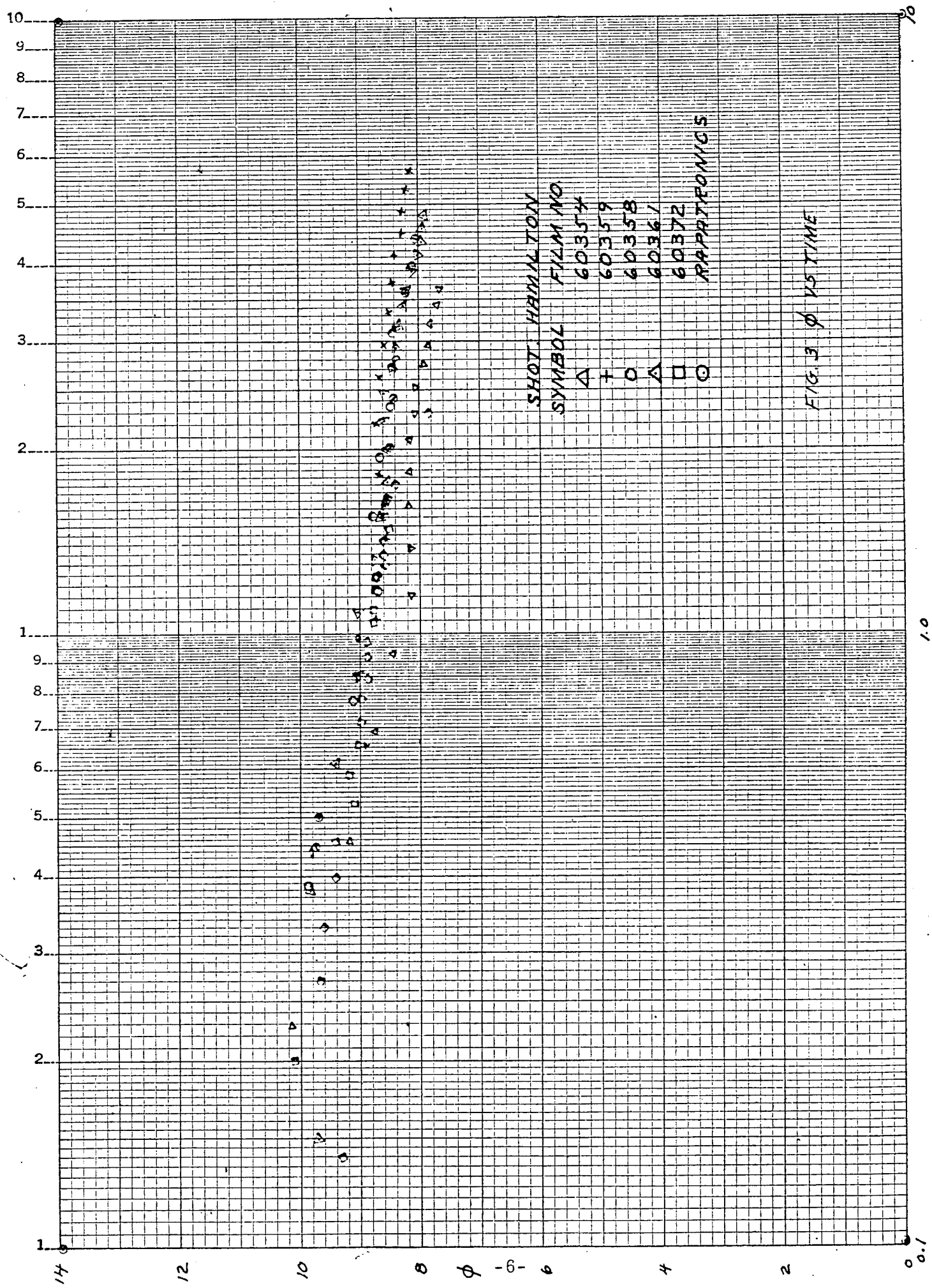
GZ STA. TF1

[illegible]

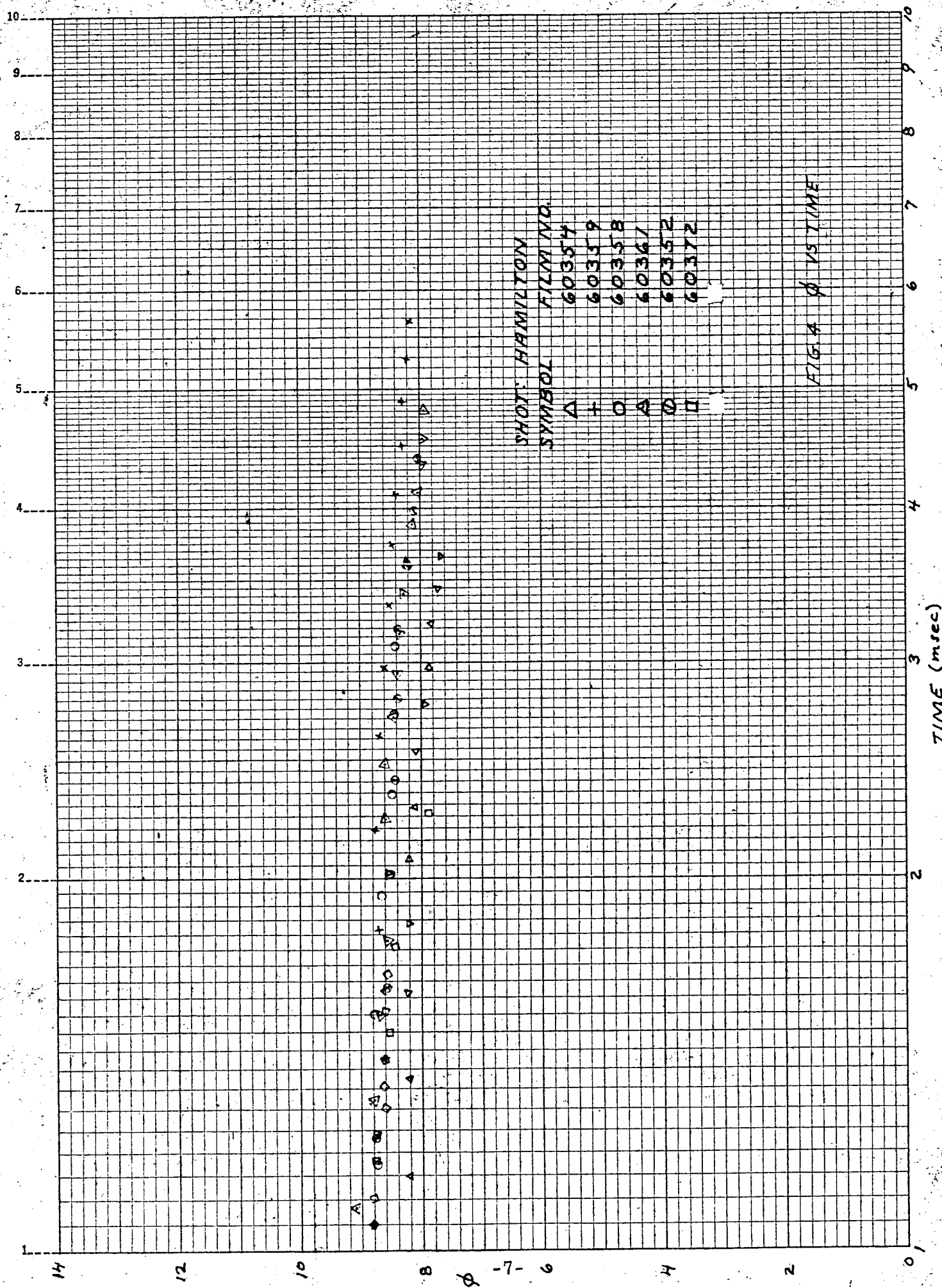
FORM E17(1-55 500)

NAME Anderson

**EDGERTON, GERMESHAUSEN & GRIER INC.**



TIME (msec)



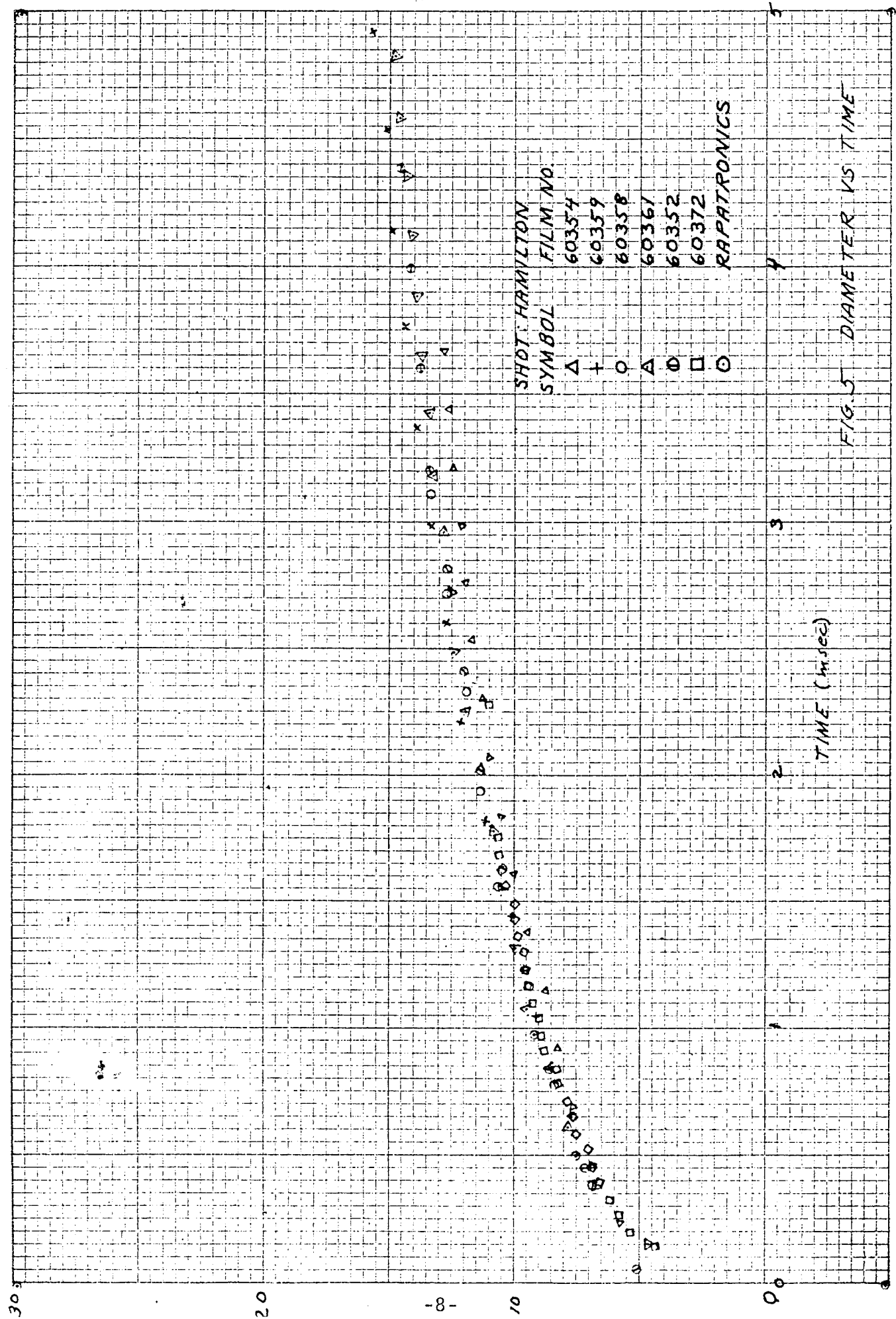


Table I  
Hardtack Phase II, Hamilton  
Fireball Camera Distribution

Station	Camera	Qualitative Functioning
527.01 (6 x 6 No. 2)	E-34	Record
	E-7	Poor Image
	F-16 No. 2	Record
	R-4	Record
	R-3	Record
527.02 (6 x 6 No. 3)	E-25	Part of F. B. Obscured
	E-6	Record
	F-16 No. 1	Record
F-732 (6 x 6 No. 1)	FR No. 1	Record

Table II  
Hardtack Phase II, Hamilton  
Average Diameter vs Time

Time (in msec.)	Diameter(meters) as seen from Stations 527.01, 527.02 and F-732
0.5	7.3
1.0	9.0
1.5	10.3
2.0	11.2
2.5	12.2
3.0	12.8
3.5	13.4
4.0	14.2
4.5	14.7

Table III

## Hardtack Phase II, Hamilton

## Rapatronic Summary

Station	Film No.	Camera	Horizional Range (m)	F. L. (mm)	Diameter(m)	Time(msec)
527.01 (6 x 6 No. 2)	60366	R-4	1196.6	477.39	7.37	0.4995
	60365	R-3	1196.6	477.82	8.99	0.9840

# PHOTO LOADING CHART

STATION 527.01 EVENT HAMILTON DATE 10-15-58

6x6 #2

STATION 527.01 6x6 #2				EVENT HAMMILTON				DATE					
FILM				CAMERA		LENS		EXPOSURE		REMARKS			
TYPE	EMULS. NO.	SIZE	HOLDER	PERF. NO.	NO.	RACK POS.	NOM. SPD.	FOC. MM.	FILTER		APER	SHUTTER RHEO.	W/M <sup>2</sup>
MF	1112-9-02	16-100	HS Reel	60358	E-34	C-1	2500	102	ND2+ W-12	f7.5	40/80	3x10 <sup>6</sup>	
FX	5240 604-02	16-100	HS Reel	60359	E-7	C-2	2500	63	ND-1+ W-12	f5	40/80	1.5x10 <sup>5</sup>	
FX	5240 624-3	35-200	MIT MAG	60360	M-26	B-2	100	16.5	W-12	f7.5	170°	Weston 700	
MF	1112-9-02	16-400	Daylight SPOOL	60361	#2 F16/4	B-1	4000	75	ND-1 W-12	f5.6	=	1x10 <sup>5</sup>	
FX	5240-626-2	70-50	Bentley MAG	60414	QL-70 #5	B-3	1/2	105	W-12	f9.0	1/100	Weston 700	
D	263368N	16-50	L-MAG	60363	#22 QSP	B-4	64	9.5	=	f4.5	133°	Weston 700	
KDC	263368N	16-50	L-MAG	60364	#5 GSP	B-4	64	9.5	=	f5.0	133°	Weston 800	
RP	6141-66207	2 1/4x3 1/4	RAP Holder	60365	R-4	A-1	40µs Coil	480	=	f11	B	3x10 <sup>5</sup>	500µs delay
RP	6141-66207	↓	↓	60366	R-3	A-2	40µs Coil	↓	=	f11	B	3x10 <sup>5</sup>	1000µs delay
					Actual				Delays				
					R-4	479 Sps			+ 20µs half coil delay				
					R-3	964 µs			+ 20µs half coil delay				
								</					

DATE FILM LOADED Rev #1 10-9-58  
 DATE CAMERA LOADED Rev #2 10-14-58  
 DATE EXPOSED 10-15-58

REMARKS FINAL

EDGERTON, GERMESHAUSEN & GRIER, INC.

FORM E-40







STATION NO. 52702  
STATION TYPE 6x6 #3  
DISTANCE GZ 1220.5'  
DISTANCE OBJECT 1221.4'

# PHOTO PLAN

BRG	358°21'	EVENT	HAMILTON
GZ	-0°10'	GZ STA.	TF 1
OBJ	2°10'	DATE	10-15-56
		POSTED	10-15-56

STATION	OBJECT TYPE	DISTANCE
N	746600	1220.5'
E	715064	1221.4'
7	3053	

**GZ**  
747 820  
715 029  
3 129

DIFF.  
1220  
- 35  
46

[illegible]

REMARKS	Rev #	Rev #	10-9-58	10-14-58
	Rev #1	Rev #2		

Enclides 50' height of Tower

# FINAL

# PHOTO LOADING CHART

STATION F 732 6x6 #1 EVENT HAMILTON DATE 10-15-58

DATE 10-15-58

[illegible]

DATE FILM LOADED	DATE CAMERA LOADED	DATE EXPOSED	REMARKS
		10-15-58	
			F.N.A.

**FORM E-40**

**EDGERTON, GERMESHAUSEN & GRIER, INC.**

PHOTO PLAN		BRG 30° 15'		EVENT HAMILTON	
GZ	DIFF.	TILT	GZ STA.	DATE	
747 820	1701	-0° 3'	TF	10-15-58	
715 029	1017	OBJ 1023'		POSTED	10-15-58
31297	48				

# PHOTO PLAN

[illegible]

REMARKS

\* Includes 50' height of tower.

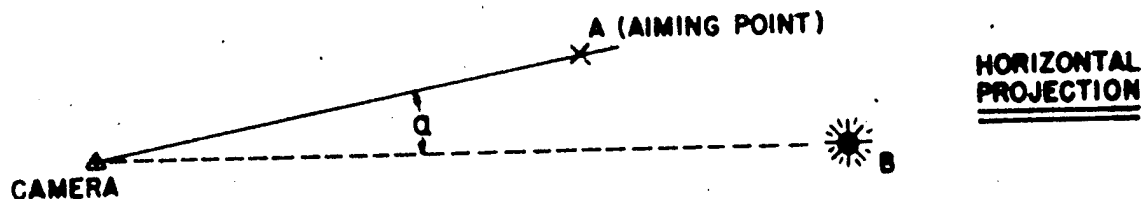
FINA:

**AD 1900**

**EDGERTON, CANNENHAUSEN & OTHER, INC.**

# CAMERA DATA & CALCULATIONS

FILM NO. 60366	STATION NO. 527.01 6x6 #2	TEST HAMILTON	CALCULATED BY: 660
CAMERA NO. R3	EQ. AP.		DATE: 10/15/58



A.  $R\%_A = CB_h \cos \alpha \cos \beta + (H_B - H_C) \sin \beta$

$\alpha = 0^\circ 00'$	$\beta = 2^\circ 12'$	$H_B = 3129 \text{ ft}$
$\cos \alpha = 1.0000$	$\cos \beta = 0.99926$	$H_C = 3079 \text{ ft}$
$CB_h = 364.7 \text{ m}$	$\sin \beta = 0.03839$	$\Delta H = 50 \text{ ft} = 15.2 \text{ m}$
$CB_h \cos \alpha \cos \beta = 364.4 \text{ m}$	$\Delta H \sin \beta = 0.6 \text{ m}$	$R\%_A = \boxed{365.0 \text{ m}}$

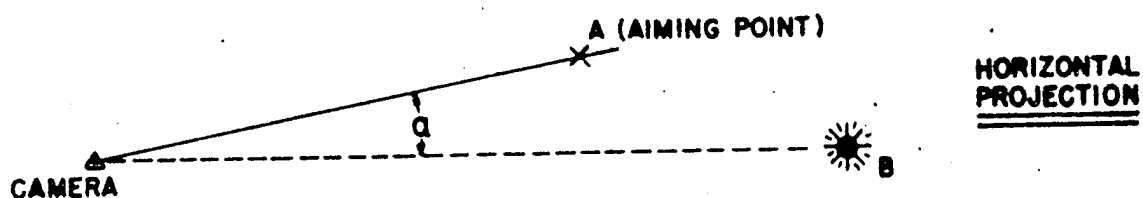
B. FOCAL LENGTH 477.39 mm (774699)

C. MAGNIFICATION FACTOR (meters/in.) 19.43

D. ZERO TIME CORRECTION 0.9840 ms delay

# CAMERA DATA & CALCULATIONS

FILM NO. 60365	STATION NO. <sup>527.01</sup> 6x6 #2	TEST HAMILTON	CALCULATED BY: GGO
CAMERA NO. R4	EQ. AP.		DATE: 10/15/58



A.  $R^{\circ}/A = CB_h \cos \alpha \cos \beta + (H_B - H_C) \sin \beta$

$\alpha = 0^{\circ} 00'$	$\beta = 2^{\circ} 12'$	$H_B = 3129 \text{ ft}$
$\cos \alpha = 1.0000$	$\cos \beta = 0.99926$	$H_C = 3079 \text{ ft}$
$CB_h = 364.7 \text{ m}$	$\sin \beta = 0.03839$	$\Delta H = 50 \text{ ft} = 15.2 \text{ m}$
$CB_h \cos \alpha \cos \beta = 364.4 \text{ m}$	$\Delta H \sin \beta = 0.6 \text{ m}$	$R^{\circ}/A = \boxed{365.0 \text{ m}}$

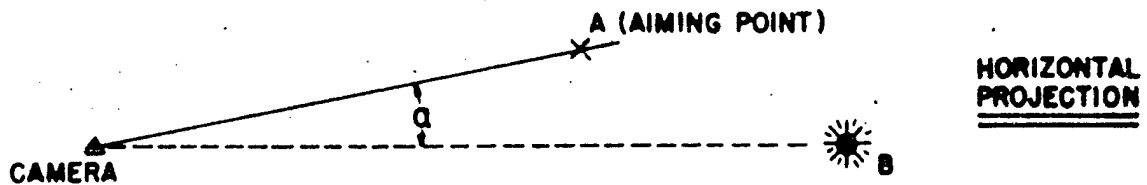
B. FOCAL LENGTH 477.82 mm (773952)

C. MAGNIFICATION FACTOR (meters/in.) 19.41

D. ZERO TIME CORRECTION 0.4995 ms delay

# CAMERA DATA & CALCULATIONS

FILM NO. 60359	STATION NO. 527.01 6x6 #2	TEST HAMILTON	CALCULATED BY: GGO
CAMERA NO. E7	EQ. AP.		DATE: 10/15/58



A. $R^0_A = CB_h \cos \alpha \cos \beta + (H_B - H_C) \sin \beta$		
$\alpha = 0^\circ 00'$	$\beta = 2^\circ 45'$	$H_B = 3129 \text{ ft}$
$\cos \alpha = 1.0000$	$\cos \beta = 0.99885$	$H_C = 3079 \text{ ft}$
$CB_h = 364.7 \text{ m}$	$\sin \beta = 0.04798$	$\Delta H = 50 \text{ ft} = 15.2 \text{ m}$
$CB_h \cos \alpha \cos \beta = 364.3 \text{ m}$	$\Delta H \sin \beta = 0.7 \text{ m}$	$R^0_A = \boxed{365.0 \text{ m}}$
B. FOCAL LENGTH 64.1 mm (ET-1207)		

C. MAGNIFICATION FACTOR (meters/in.) 144.6
--

D. ZERO TIME CORRECTION 0.28 ms
---------------------------------



SHOT HAMILTON

FILM NO. 60359

READ BY \_\_\_\_\_ PLW \_\_\_\_\_ GGO \_\_\_\_\_ TYPED BY \_\_\_\_\_

DATE 10/23/58 DATE

REMARKS :

# FIREBALL CALCULATIONS

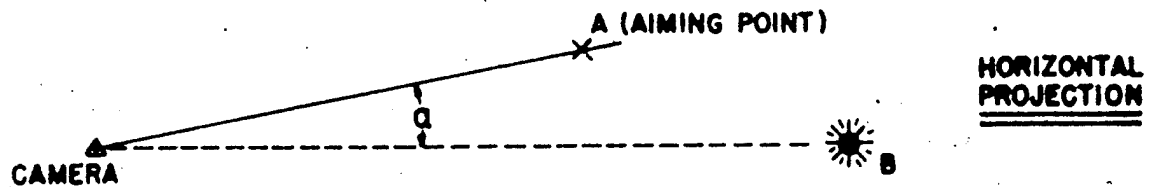
SHOT Hamilton FILM NO. 60359

DATE 1-22-59

D	t	ln D	Int	$t^{2/5}$	$\phi$
7.58	.66	2.02551	415.59 -	8.46845	89.50
8.95	1.05	2.19172	48.76	10.19697	87.77
9.95	1.44	2.29750	364.69	11.57056	85.99
11.10	1.82	2.40687	598.87	12.70678	87.35
12.08	2.21	2.49149	792.93	13.73243	87.96
12.73	2.60	2.54394	955.43	14.65468	86.86
13.33	2.98	2.59003	1091.89	15.47680	86.12
13.88	3.37	2.63048	1214.94	16.25763	85.37
14.40	3.76	2.66728	1324.48	16.98585	84.77
14.88	4.14	2.70009	1420.77	17.65278	84.29
15.23	4.53	2.72334	1510.77	18.29989	83.22
15.73	4.91	2.75565	1591.29	18.89885	83.23
16.05	5.30	2.77579	1667.68	19.48525	82.36
16.40	5.69	2.79736	1738.65	20.04633	81.81

# CAMERA DATA & CALCULATIONS

FILM NO. 60358	STATION NO. 527.01 6x6 #2	TEST HAMILTON	CALCULATED BY: GGO
CAMERA NO. E34	EQ. AP.		DATE: 10/15/58



A.  $R\%_A = CB_h \cos \alpha \cos \beta + (H_B - H_C) \sin \beta$

$\alpha = 0^\circ 00'$	$\beta = 2^\circ 04'$	$H_B = 3129 \text{ ft}$
$\cos \alpha = 1.0000$	$\cos \beta = 0.99935$	$H_C = 3079 \text{ ft}$
$CB_h = 364.7 \text{ m}$	$\sin \beta = 0.03606$	$\Delta H = 50 \text{ ft} = 15.2 \text{ m}$
$CB_h \cos \alpha \cos \beta = 364.5 \text{ m}$	$\Delta H \sin \beta = 0.55 \text{ m}$	$R\%_A = \boxed{365.1 \text{ m}}$

B. FOCAL LENGTH 101.6 mm (RC 128)

C. MAGNIFICATION FACTOR (meters/in.) 91.27

D. ZERO TIME CORRECTION 0.004 ms

E-34

FILM NO. 60358

READ BY 273 350 TYPED BY \_\_\_\_\_  
DATE 19/5/58 10/15/58 DATE \_\_\_\_\_  
REMARKS: \_\_\_\_\_

**EDGERTON, GERMESHAUSEN  
& GRIER, INC.**

# FIREBALL CALCULATIONS

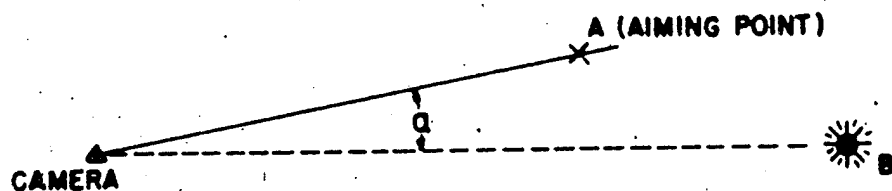
SHOT Hamilton FILM NO. 60358

DATE 1-22-59

D	t	ln D	Int	$t^{2/3}$	$\phi$
6.80	.39	1.91685	.94153 -	.686180	99.09
8.32	.78	2.11872	248.44 -	9.05399	91.89
9.32	1.17	2.23221	156.93	10.64784	87.52
10.55	1.56	2.35609	444.75	11.94711	88.30
11.31	1.94	2.42561	662.69	13.03533	86.76
11.94	2.33	2.47983	845.79	14.02588	85.12
12.63	2.72	2.53604	1000.56	14.92163	84.64
13.32	3.11	2.58927	1134.61	15.74355	84.60

# CAMERA DATA & CALCULATIONS

FILM NO. 60361	STATION NO. 527.01 6x6 #2	TEST HAMILTON	CALCULATED BY: GGO
CAMERA NO. F-16 #2	EQ. AP.		DATE: 10/15/58



HORIZONTAL  
PROJECTION

A.  $R^0_A = CB_h \cos \alpha \cos \beta + (H_B - H_C) \sin \beta$

$\alpha = 0^\circ 00'$	$\beta = 2^\circ 15'$	$H_B = 3129 \text{ ft}$
$\cos \alpha = 1.0000$	$\cos \beta = 0.99923$	$H_C = 3079 \text{ ft}$
$CB_h = 364.7 \text{ m}$	$\sin \beta = 0.03926$	$\Delta H = 50 \text{ ft} = 15.2 \text{ m}$
$CB_h \cos \alpha \cos \beta = 364.4 \text{ m}$	$\Delta H \sin \beta = 0.6 \text{ m}$	$R^0_A = 365.0 \text{ m}$

B. FOCAL LENGTH 78.06 mm (617086)

C. MAGNIFICATION FACTOR (meters/in.) 118.8

D. ZERO TIME CORRECTION 0.15 ms

## DIAMETER MEASUREMENTS

SHOT Hamilton

FILM NO. 60361

[illegible]

READ BY GGO LW TYPED BY

DATE 10/28/58 DATE

REMARKS:

**EDGERTON, GERMESHAUSEN  
& GRIER, INC.**

# FIREBALL CALCULATIONS

SHOT Hamilton FILM NO. 60361

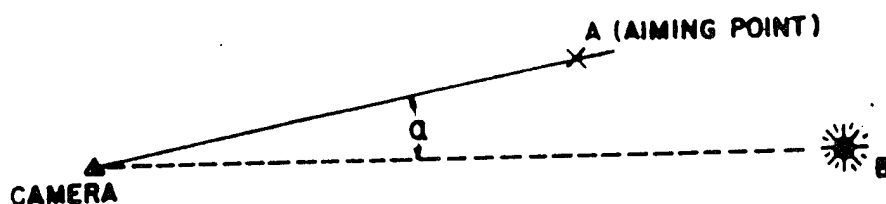
DATE 1-22-59

D	t	ln D	Int	$t^{2/3}$	$\phi$
4.58	.15	1.52174	1.89705 -	.468217	9.781
6.74	.38	1.90799	.96751 -	.679086	99.25
7.79	.61	2.05285	49437 -	8.20574	94.93
8.53	.85	2.14366	16245 -	9.37085	91.02
9.39	1.08	2.23968	7690	10.31239	91.05
9.86	1.32	2.28844	27763	11.17454	88.23
10.36	1.55	2.33795	43833	11.91642	86.93
10.79	1.78	2.37856	57666	12.59438	85.67
11.34	2.02	2.42826	70308	13.24763	85.60
11.94	2.25	2.47983	81086	13.83128	86.32
12.41	2.48	2.51846	90818	14.38027	86.29
12.64	2.72	2.53684	100056	14.92163	84.70
12.93	2.95	2.55954	108177	15.41426	83.88
13.25	3.18	2.58400	115688	15.88441	83.41
13.54	3.42	2.60567	122967	16.35373	82.79
13.81	3.65	2.62542	129478	16.78525	82.27
14.02	3.88	2.64053	135591	17.20068	81.50
14.18	4.12	2.65188	141592	17.61863	80.48
14.39	4.35	2.66659	147024	18.00558	79.91
14.67	4.58	2.68587	152174	18.38039	79.81
14.94	4.82	2.70411	157280	18.75959	79.63



# CAMERA DATA & CALCULATIONS

FILM NO. 60352	STATION NO. 527.02 6x6 #3	TEST HAMILTON	CALCULATED BY: GGO
CAMERA NO. E 6	EQ. AP.		DATE: 10/15/58



HORIZONTAL  
PROJECTION

A. $R^0/A = CB_h \cos \alpha \cos \beta + (H_B - H_C) \sin \beta$			
$\alpha = 0^\circ 00'$	$\beta = 2^\circ 10'$	$H_B = 3129 \text{ ft}$	
$\cos \alpha = 1.0000$	$\cos \beta = 0.99929$	$H_C = 3083 \text{ ft}$	
$CB_h = 372.0 \text{ m}$	$\sin \beta = 0.03781$	$\Delta H = 46 \text{ ft} = 14 \text{ m}$	
$CB_h \cos \alpha \cos \beta = 371.7 \text{ m}$	$\Delta H \sin \beta = 0.5 \text{ m}$	$R^0/A = $	<span style="border: 1px solid black; padding: 2px;">372.2 m</span>
FOCAL LENGTH 63.91 mm (ET 1254)			

MAGNIFICATION FACTOR (meters/in.) 147.9

ZERO TIME CORRECTION 0.05 ms

# FIREBALL CALCULATIONS

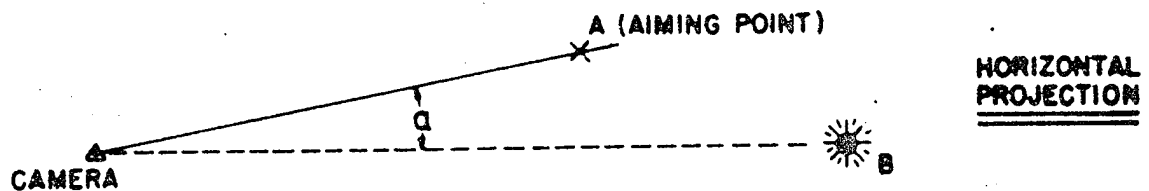
SHOT Hamilton FILM NO. 60352

DATE 1-22-59

t	ln D	Int	$t^{2/3}$	$\phi$
.05	1.61343	2.09572 -	.301722	16637
45	1.96286	79845 -	7.26597	9799
84	2.14248	17429 -	9.32657	9135
123	2.25342	20696	10.86309	8763
163	2.34563	48865	12.15873	8586
202	2.42384	70308	13.24763	8522
241	2.48568	87955	14.21653	8447
281	2.54158	103313	15.11726	8400
320	2.59452	116315	15.92432	8408
360	2.62252	128099	16.69287	8249
399	2.65047	138386	17.39412	8140
438	2.68040	147711	18.05514	8080

# CAMERA DATA & CALCULATIONS

FILM NO. 60354	STATION NO. <sup>527.02</sup> 6x6 #3	TEST HAMILTON	CALCULATED BY: GGO
CAMERA NO. F16 #1	EQ. AP.		DATE: 10/15/58



A.  $R\%_A = CB_h \cos \alpha \cos \beta + (H_B - H_C) \sin \beta$

$\alpha = 0^\circ 00'$	$\beta = 2^\circ 10'$	$H_B = 3129 \text{ ft}$
$\cos \alpha = 1.0000$	$\cos \beta = 0.99929$	$H_C = 3083 \text{ ft}$
$CB_h = 372.0 \text{ m}$	$\sin \beta = 0.03781$	$\Delta H = 46 \text{ ft} = 14 \text{ m}$
$CB_h \cos \alpha \cos \beta = 371.7 \text{ m}$	$\Delta H \sin \beta = 0.5 \text{ m}$	$R\%_A = \boxed{372.2 \text{ m}}$

B. FOCAL LENGTH 77.96 mm (617071)

C. MAGNIFICATION FACTOR (meters/in.) 121.3

D. ZERO TIME CORRECTION 0.002 ms

## DIAMETER MEASUREMENTS

FILM NO. 60354

**milton**

[illegible]

BY                      OGO JEC TYPED BY                     

10/28/58 DATE

**LINKS :**

**EDGERTON, GERMESHAUSEN  
& GRIER, INC.**

# FIREBALL CALCULATIONS

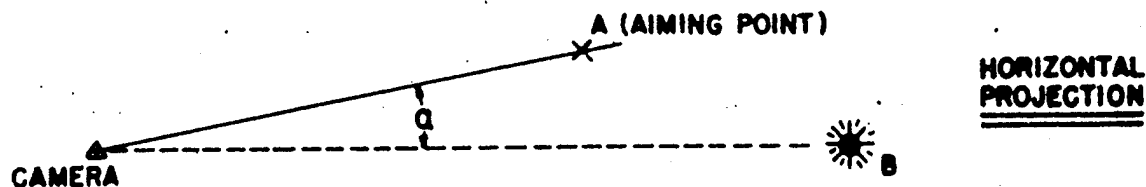
607 FILM NO. 60354

DATE 1-22-59

ln D	Int	$t^{2/5}$	$\phi$
233 36	1.469 74 -	.5 554 93	10.1 89
112 43	776 48 -	7 330 11	92 35
128 14	371 12 -	8 620 42	88 16
06 62	83 32 -	9 672 19	84 98
59 94	139 68	10 574 64	81 98
35 42	322 11	11 375 14	82 19
02 66	476 31	12 098 84	82 65
47 54	609 80	12 762 43	81 95
96 01	727 52	13 377 76	82 07
26 49	832 84	13 953 38	81 12
62 93	928 14	14 495 55	80 99
80 67	1 015 17	15 009 04	79 61
01 38	1 091 89	15 476 80	78 82
25 69	1 166 27	15 944 22	78 39
40 00	1 235 51	16 391 94	77 35
60 31	1 300 25	16 821 99	76 92

# CAMERA DATA & CALCULATIONS

NO. 60372	STATION NO. F-732 6x6 #1	TEST HAMILTON	CALCULATED BY: GGO
ERA NO. FR #1	EQ. AP.		DATE: 10/15/58



$$R^0/A = CB_h \cos \alpha \cos \beta + (H_B - H_C) \sin \beta$$

$0^\circ 00'$	$\beta = 1^\circ 23'$	$H_B = 3129 \text{ ft}$
$\alpha = 1.0000$	$\cos \beta = 0.99971$	$H_C = 3081 \text{ ft}$
$= 604.1 \text{ m}$	$\sin \beta = 0.02414$	$\Delta H = 48 \text{ ft} = 14.6 \text{ m}$
$\cos \alpha \cos \beta = 603.9 \text{ m}$	$\Delta H \sin \beta = 0.4 \text{ M}$	$R^0/A = \boxed{604.3 \text{ m}}$

FOCAL LENGTH

MAGNIFICATION FACTOR (meters/in.)

ZERO TIME CORRECTION 0.006 ms

## DIAMETER MEASUREMENTS

**SHOT Hamilton**

FILM NO. 60372

Fr. No.	Mag.	D <sub>1</sub>	D <sub>2</sub>	D <sub>3</sub>	D <sub>avg</sub> (m)	FLEXOWRITER	
						D <sub>avg</sub> (m)	t (ms)
0	19.33	XXXX	XXXX		—		—
1		XXXX	XXXX		—		—
2		0134	0139		4.26		0.14
3		0169	0176		5.31		0.20
4		0182	0190		5.77		0.27
5		0198	0200		6.19		0.33
6		0212	0211		6.56		0.40
7		0222	0230		6.94		0.46
8		0235	0235		7.10		0.53
9		0249	0249		7.49		0.59
10		0253	0255		7.67		0.66
11		0257	0259		7.89		0.72
12		0267	0265		8.19		0.79
13		0273	0276		8.34		0.85
14		0279	0283		8.65		0.92
15		0281	0286		8.87		0.98
16		0288	0289		8.97		1.05
17		0297	0301		9.18		1.11
18		0300	0304		9.36		1.18
19		0306	0307		9.53		1.24
20		0312	0314		9.58		1.31
21		0317	0320		9.81		1.37
22		0325	0326		9.96		1.44
23		0329	0330		10.02		1.50
24		0335	0336		10.33		1.57
25		0336	0341		10.46		1.63
26		0342	0343		10.55		1.69
27		0348	0349		10.56		1.76
35		0354	0355		10.99		2.28

READ BY JEC RCS

TYPED BY JEC

DATE 1/14/59

DATE 1/14/59

REMARKS:

# FIREBALL CALCULATIONS

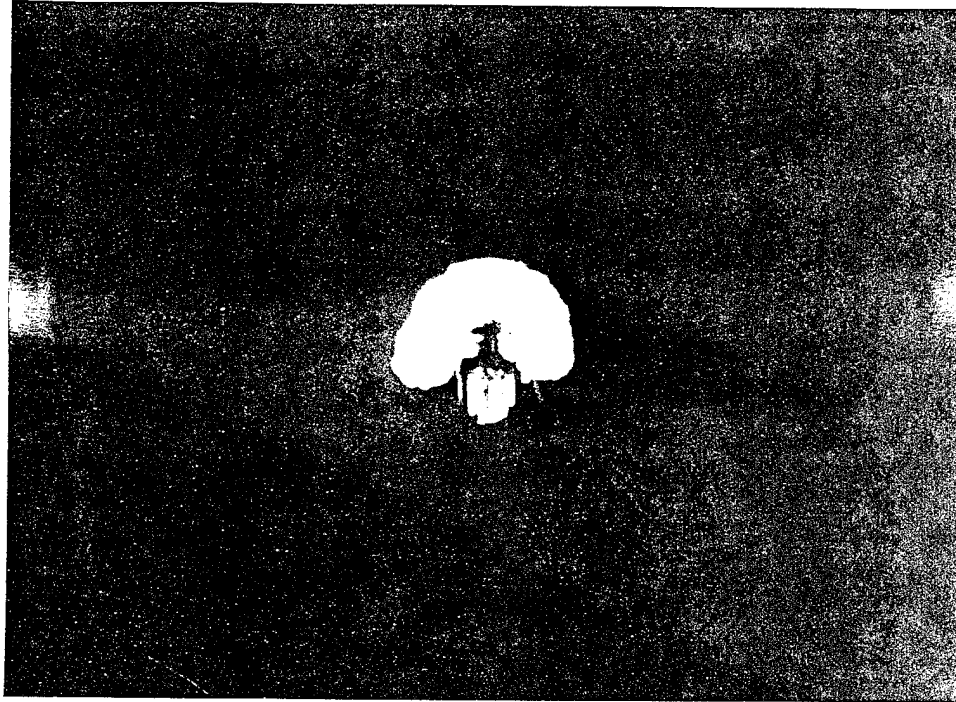
SHOT Hamilton FILM NO. 60372

DATE 1-22-59

D	t	ln D	Int	t <sup>2/5</sup>	φ
4.26	.14	1.44934	1.96607 -	.455467	93.53
5.31	.20	1.66956	1.60945 -	5.25303	101.08
5.77	.27	1.75260	1.30940 -	5.92288	97.41
6.19	.33	1.82285	1.10864 -	6.41812	96.44
6.56	.40	1.88091	.91621 -	6.93164	94.63
6.94	.46	1.93724	.77648 -	7.33011	94.67
7.10	.53	1.96005	.63490 -	7.75720	91.52
7.49	.59	2.01355	.52770 -	8.09707	92.50
7.67	.66	2.03732	.41559 -	8.46845	90.57
7.89	.72	2.06562	.32854 -	8.76851	89.98
8.19	.79	2.10296	.23569 -	9.10028	89.99
8.34	.85	2.12112	.16245 -	9.37085	88.99
8.65	.92	2.15763	.8332 -	9.67219	89.43
8.87	.98	2.18275	.2023 -	9.91939	89.42
8.97	1.05	2.19396	.4876	10.19697	87.96
9.18	1.11	2.21709	104.28	10.42596	88.04
9.36	1.18	2.23649	165.44	10.68416	87.60
9.53	1.24	2.25446	215.06	10.89836	87.44
9.58	1.31	2.25969	270.02	11.14057	85.99
9.81	1.37	2.28337	314.83	11.34208	86.49
9.96	1.44	2.29851	364.69	11.57056	86.08
10.02	1.50	2.30465	405.53	11.76111	85.19
10.33	1.57	2.33505	451.15	11.97769	86.24
10.46	1.63	2.34754	488.65	12.15873	86.02
10.55	1.69	2.35609	524.79	12.33578	85.52
10.56	1.76	2.35704	565.37	12.53761	84.22
10.99	2.28	2.39692	824.11	13.90473	79.03



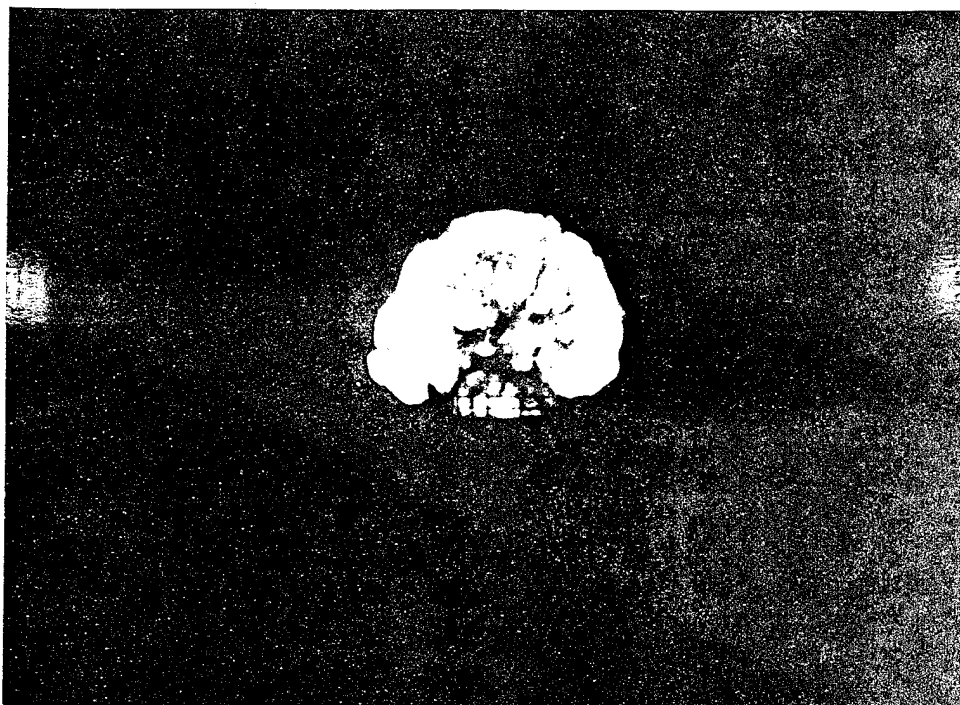
APPENDIX  
HARDTACK PHASE II, HAMILTON  
PHOTOGRAPHIC EXAMPLES



Camera: F-16 No. 2

Station: 527.01

Time: 0.38 msec



Camera: F-16 No. 2

Station: 527.01

Time: 1.08 msec



Camera: F-16 No. 2

Station: 527.01

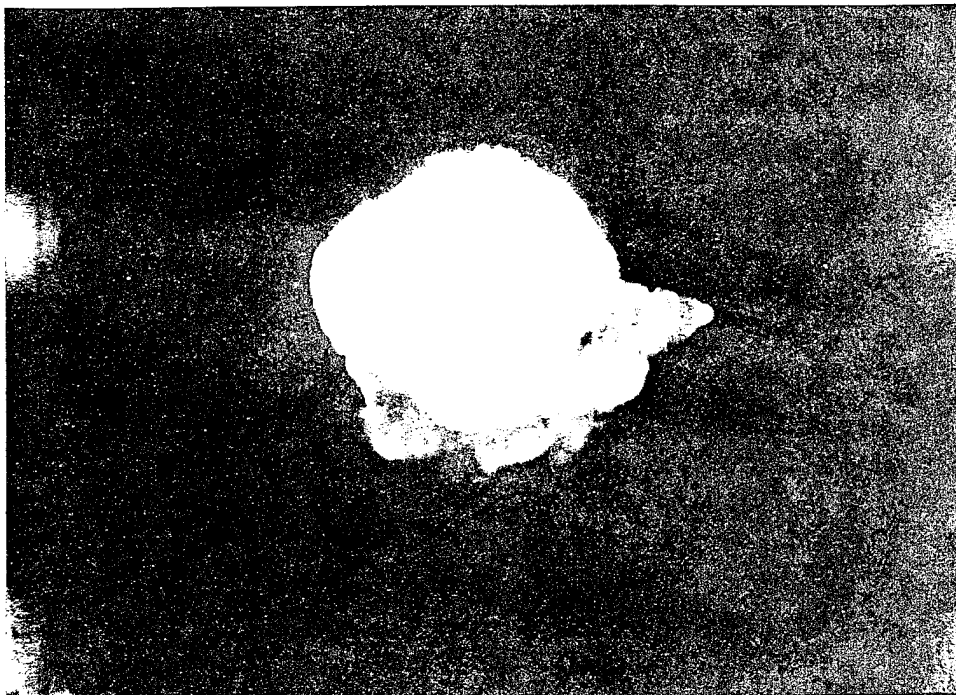
Time: 2.02 msec



Camera: E-6

Station: 527.02

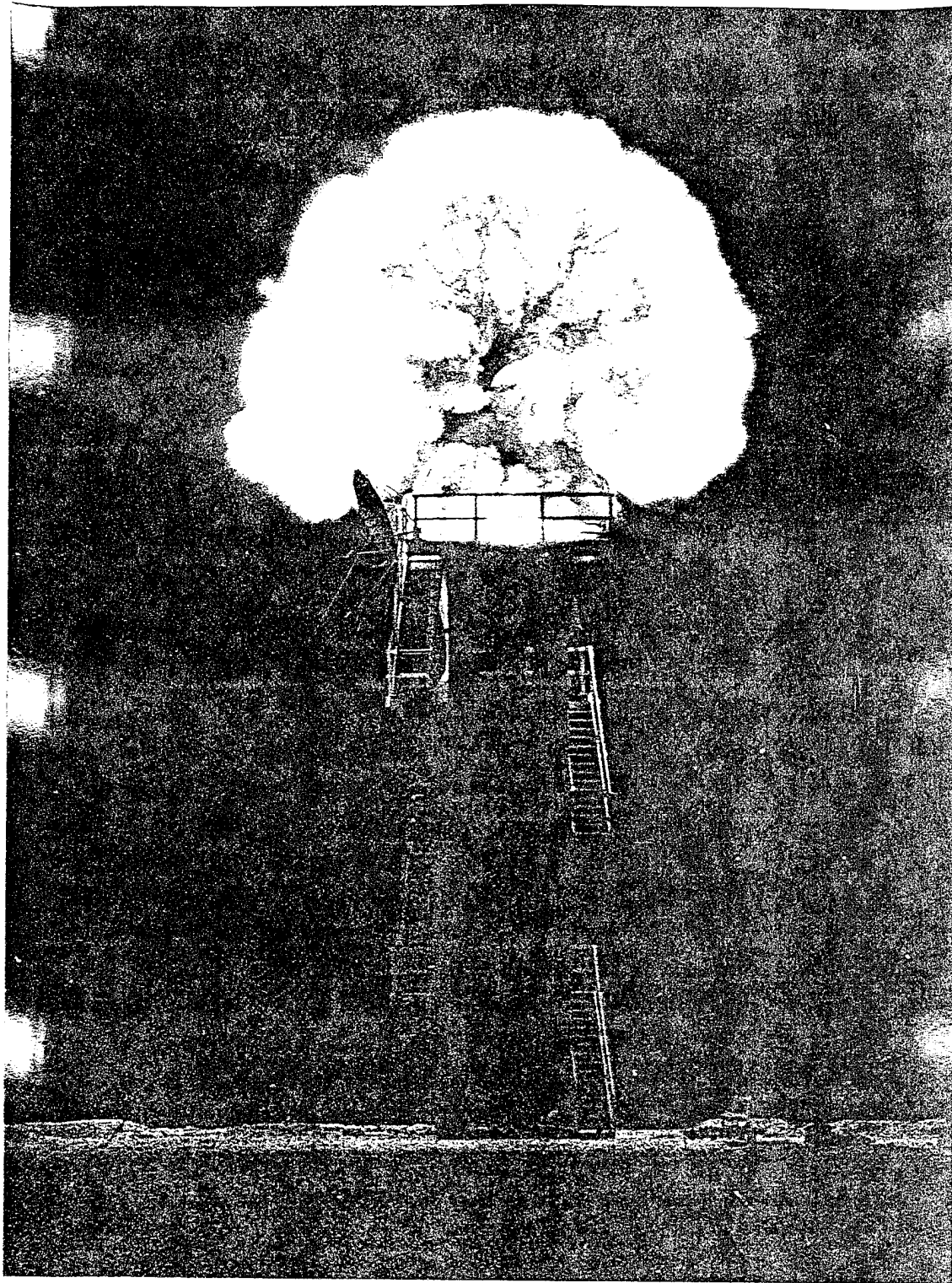
Time: 2.02 msec



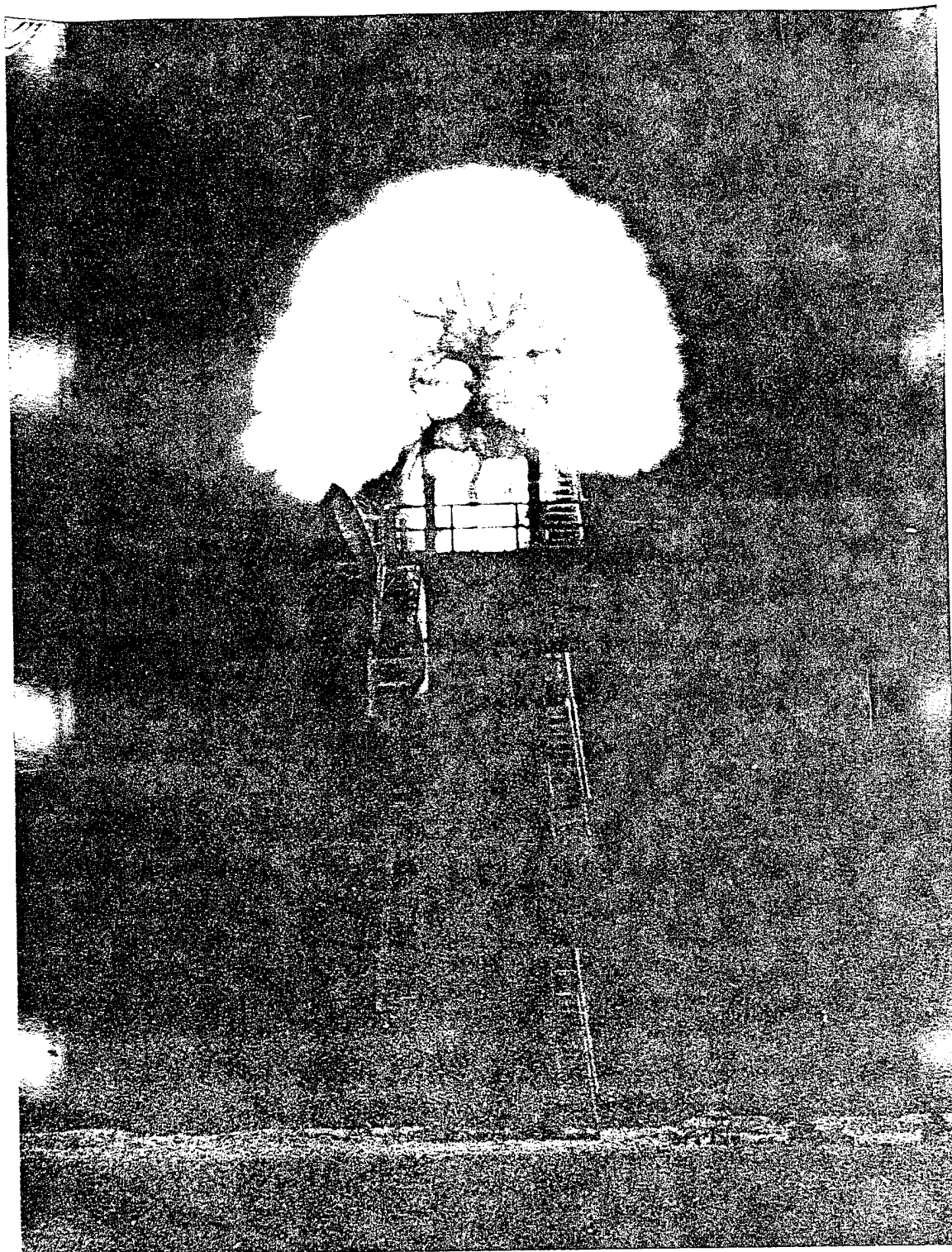
Camera: E-6

Station: 527.02

Time: 6.74 msec



Camera: R-4  
Station: 527.01  
Time: 0.4995 msec



Camera: R-3  
Station: 527.01  
Time: 0.9840 msec



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